Nov. 13, 1928. 1,691,269

T. F. CROCKER

WIRE CHIEF'S TEST CIRCUITS FOR TELEPHONE SYSTEMS

Filed Dec. 9, 1925 4 Sheets-Sheet 1

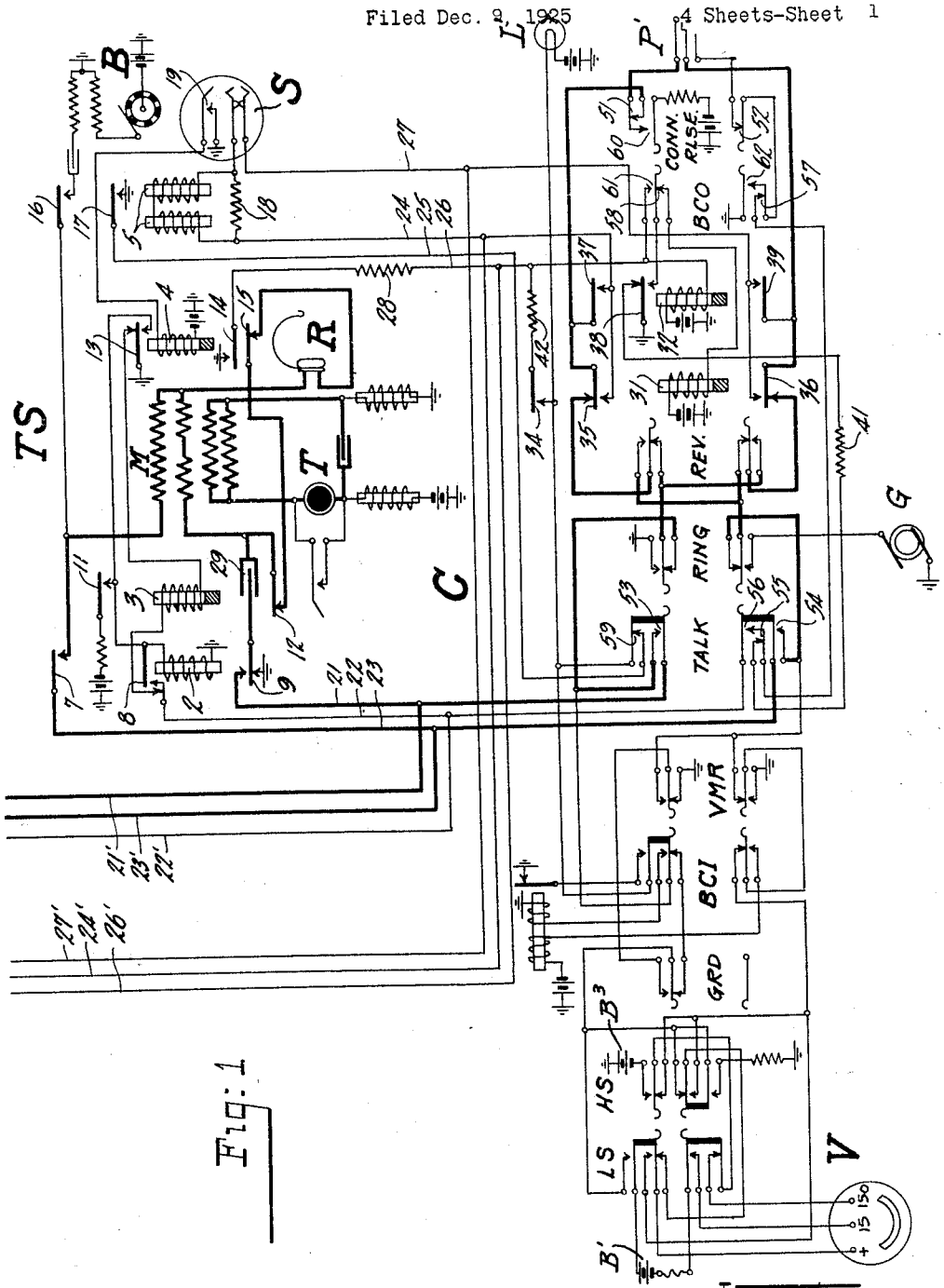


Fig. 1

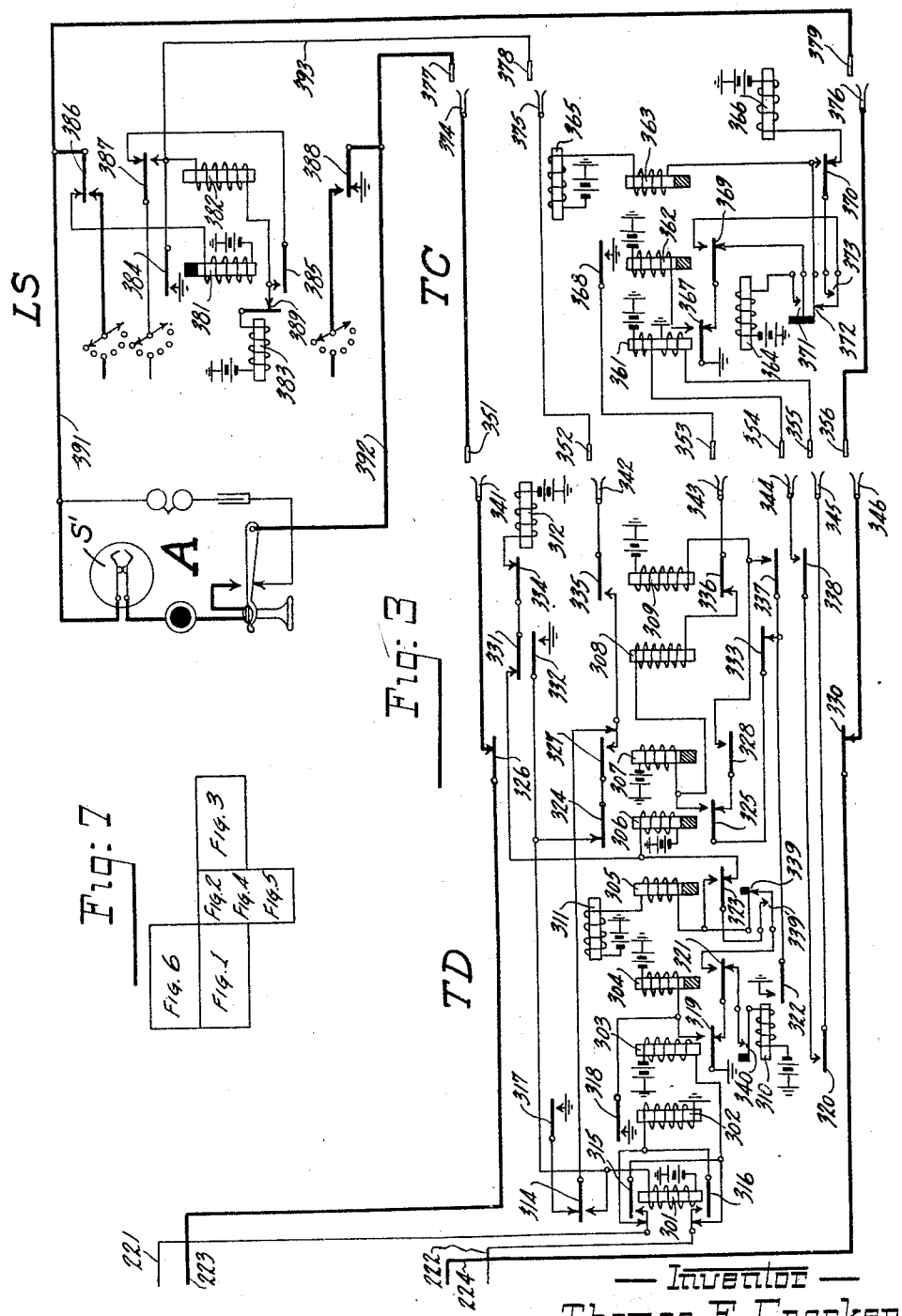
Inventor
Thomas F. Crocker
R. B. Richardson Atty.

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T. F. CROCKER

WIRE CHIEF'S TEST CIRCUITS FOR TELEPHONE SYSTEMS

Filed Dec. 9, 1925 4 Sheets-Sheet 2



— Inventor —

Thomas F. Crocker

A. B. Richardson Atty.

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T. F. CROCKER

WIRE CHIEF'S TEST CIRCUITS FOR TELEPHONE SYSTEMS

Filed Dec. 9, 1925 4 Sheets-Sheet 3

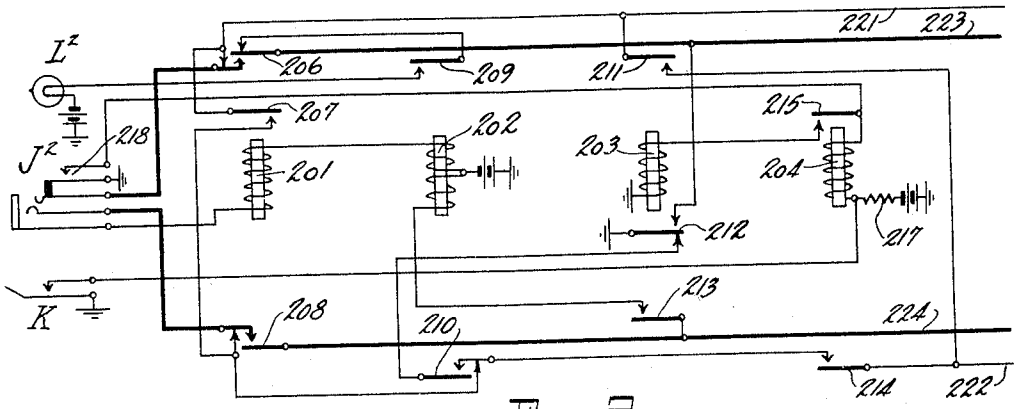


Fig: 2

Fig: 4

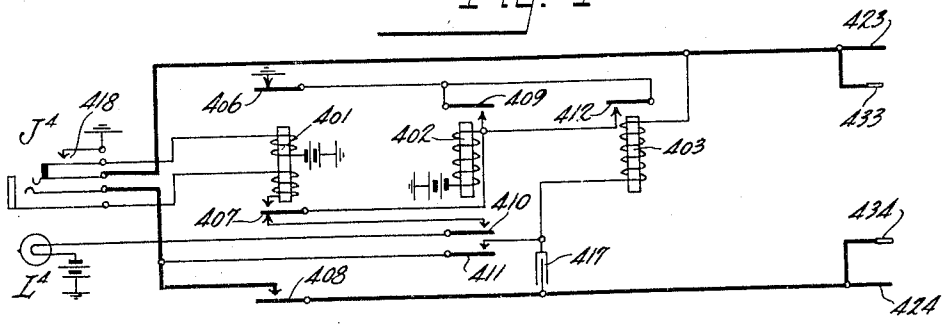
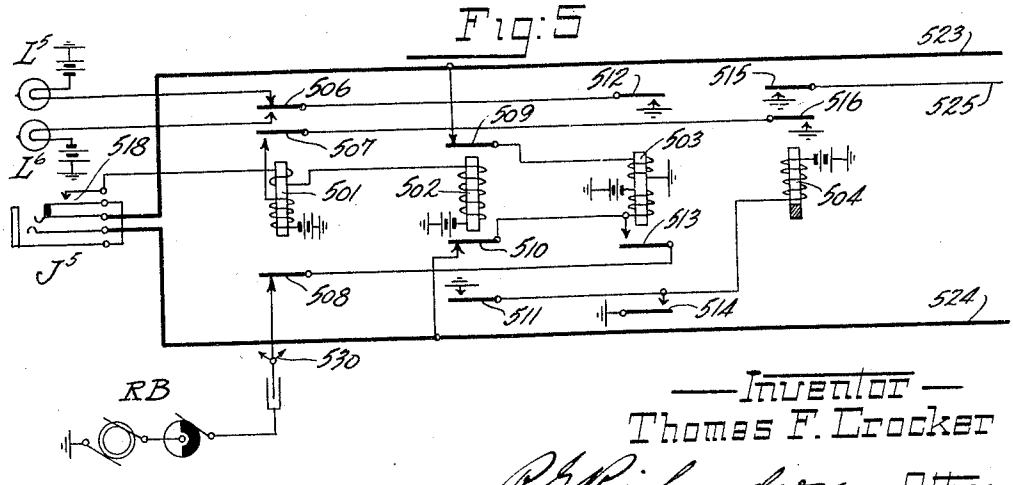


Fig: 5



Inventor
Thomas F. Crocker
R. B. Richardson Atty:

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T. F. CROCKER

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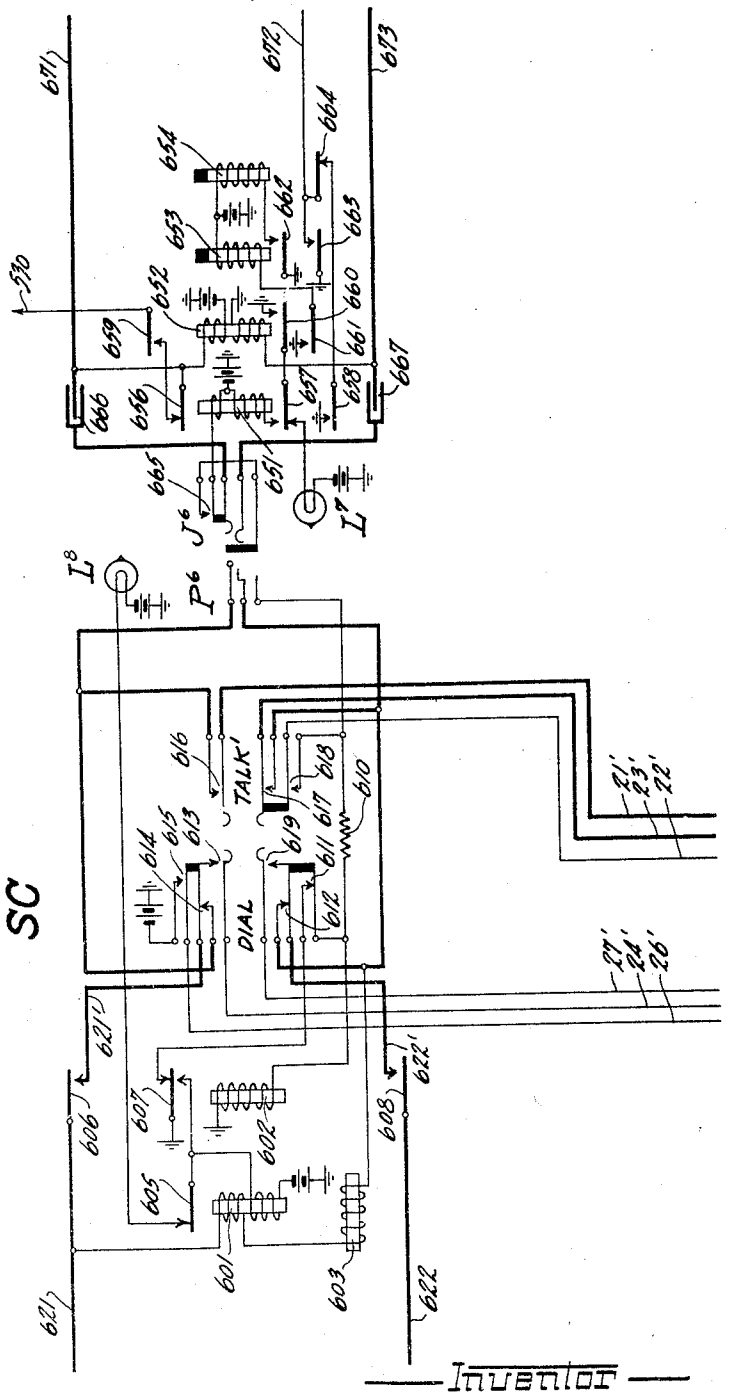


Fig. 6

Inventor
Thomas F. Crocker
R. B. Richardson Atty.

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UNITED STATES PATENT OFFICE.

THOMAS F. CROCKER, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO AUTOMATIC ELECTRIC INC., OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE.

WIRE CHIEF'S TEST CIRCUITS FOR TELEPHONE SYSTEMS.

Application filed December 9, 1925. Serial No. 74,231.

This invention relates in general to wire chiefs' test circuits for telephone systems, but is concerned more particularly with testing circuits especially adapted for use in automatic telephone systems. The object of this invention, comprehensively stated, is the provision of revised and improved testing circuits for the wire chief's position, which facilitate and promote speed and accuracy in the performance of the various tests to be made by the wire chief.

The performance of the regular routine tests of the subscribers' lines is one of the principal duties of the wire chief. In the performance of these tests, the operation of keys is a considerable part of the labor that must be performed by the wire chief in making the various tests or in establishing testing connections to subscribers' lines. To establish a connection with a subscriber's line, or with a second subscriber's line after the completion of the testing of the first subscriber's line, it has been necessary for the wire chief to operate a dialling key before the necessary digits to establish the first or the second connection could be dialled. According to a special feature of this connection, the number of key operations that must be performed to make the required tests on lines has been reduced by eliminating the necessity of operating a dialling key when a new connection is desired. In this new test cord, the preparation of the circuits for dialling is automatically performed by relay operations, which are initiated by the movement of the calling device from its normal position.

Another feature of this new testing circuit relates to a busy tone and the supervision which is given to the wire chief when he has established a connection with a busy subscriber's line. The circuits are so designed that the busy tone is heard by the wire chief and a supervisory lamp is lighted when a connection is established with a busy subscriber's line, and are so arranged that the supervisory lamp is extinguished and the busy tone is removed when the listening key in the test cord is thrown, making it possible for the wire chief to then listen to the conversation of the busy subscribers and verify the busy condition of the line.

Another feature of this invention pertains to a special supervisory arrangement, whereby a connection having been established either with a subscriber's substation or with a trouble man on a subscriber's line, will not be released by the removal of the test cord plug from the outgoing trunk jack, supervision being had by means of a supervisory lamp individual to the outgoing trunk. With such an arrangement, the wire chief may set up connections with several trouble men or subscribers' lines, each over a different outgoing trunk from the wire chief's position, and may then perform the required tests on any line as is desired or requested by trouble men who may be making adjustments out on the lines. The connection of the test cord may be shifted from one established connection to another by merely transferring the test plug from one trunk jack to the other trunk jack.

Another minor feature of this invention relates to the dual function of a certain relay in a trunk circuit of the trunk terminating at the wire chief's position for general incoming and outgoing service for the wire chief. This relay operates in series with a condenser responsive to ringing current to signal the wire chief on incoming calls and is included in the holding bridge independent of these condensers on outgoing calls.

In small telephone systems, the wire chief may be required to render special services, such as information and complaint service or act in the capacity of a so-called "zero" operator, in addition to performing the regular duties of a wire chief. Accordingly, in this invention is included a new and improved single ending cord circuit especially designed for use in conjunction with the telephone set of the wire chief's testing equipment, by which an incoming call from one subscriber may be extended by the wire chief to another desired subscriber's line.

These various features and other features, not specially mentioned, will be described more in detail in the following specification in connection with the explanation of the operation of the various circuits which are described with the aid of the accompanying drawings.

Referring now to the drawings comprising Figs. 1–7, inclusive, there is shown by means of the usual circuit diagrams, the testing equipment, the trunk circuits of the various kinds of trunks terminating at the

wire chief's position, and sufficient auxiliary apparatus that is brought into play in making various tests to clearly describe the features and utility of the invention. The drawings are to be placed with their corresponding lines in alignment, in the order shown in the diagram, Fig. 7. In Fig. 1, are shown the test circuits proper and the necessary auxiliary apparatus associated therewith. In Figs. 2, 4, and 5 are shown three trunks with their individual trunk circuits terminating at the wire chief's position. Fig. 3 shows the circuits of three automatic switches, known, respectively, as a test distributor, a test connector, and a rotary line switch, which is individual to the subscriber's line to the automatic substation A. In Fig. 6 is shown the special single ending cord to be used in connection with the wire chief's telephone set shown in Fig. 1. A trunk terminating at the wire chief's position with which the single ending cord SC is to be used, is also shown in Fig. 6.

The wire chief's testing equipment proper consists of a telephone set TS and the test cord C, Fig. 1. The telephone set includes the transmitter T, receiver R, calling device S, and certain relays having special functions that will be described subsequently. The test cord is equipped with the usual keys which, in being operated, perform functions or prepare the circuits for making the various tests, as is known to those skilled in the art. Several special relays asociated with the test cord have special functions peculiar to this invention and will be described later.

The trunk comprising conductors 221–224, inclusive, terminating in the jack J^2, Fig. 2, is one of a group of trunks terminating at the wire chief's position, each of which is permanently connected to a test distributor, such as TD, Fig. 3. Connections to the subscribers' lines for general routine testing are established over this trunk or a similar trunk.

The trunk comprising conductors 423 and 424, terminating in the jack J^4, Fig. 4, is permanently connected to an individual line switch, which may be similar to the line switch, LS, shown in Fig. 3. This trunk is also accessible in the connector bank contacts 433 and 434 or multiples thereof. This trunk is individual to the wire chief's position and is used for general incoming or outgoing service to or from the wire chief.

The trunk comprising conductors 523–525, inclusive, terminating at the wire chief's position in the jack J^5, Fig. 5, is one of several trunk lines accesible in a certain level of bank contacts of a certain group of selectors. The code number for establishing a connection over this trunk is not listed in the general directory, this trunk being reserved for use by trouble men who may be out in the field testing the subscribers' lines and who wish to establish communication with the wire chief.

The test distributor TD, shown in Fig. 3, mechanically is of the Strowger step-by-step type, having ten horizontal rows or levels of bank contacts, and is responsive to two digits to move its wipers in a vertical and in a rotary motion. The test connector TC also is mechanically of a Strowger step-by-step vertical and rotary type, functioning in response to two digits dialled by the wire chief to raise its wipers and then rotate them into engagement with the corresponding bank contacts at which a subscriber's line such as the line comprising conductors 391 and 392 terminates.

Each subscriber's line terminates in an individual primary line switch. Individual to the subscriber's line to substation A is the line switch LS which is of the rotary type whose wipers have no normal position and rotate in a forward direction only, by means of which a connection to an idle switch for an outgoing call may be established. The substation A is of the usual automatic type having the usual talking instrumentalities and the calling device S′.

The single ending cord SC, shown in Fig. 6, is permanently associated with the wire chief's telephone set TS by the conductors 21′—24′, inclusive, 26′ and 27′. This cord terminates at one end in the answering plug P^6 and is permanently connected to an individual line switch which also may be of the rotary type similar to the line switch LS shown in Fig. 3. This cord is provided with a dialling key and a talking key and special relays, having functions that will be described later. The trunk, comprising conductors 671–673, inclusive, and terminating at the wire chief's position in the jack J^6, is one of a group of similar trunks accessible in the bank contacts of a certain group of selectors. The code number for establishing a connection to the wire chief over this trunk is listed in the general directory and may be used by the local subscriber for establishing connections to the wire chief's position for such special service, as may be assigned.

A detailed description of the trunking between the test switches is thought to be unnecessary. From the foregoing, however, it is evident that a 10,000 line capacity system requiring the dialling of four digits to establish a connection has been assumed. There will be 100 groups of connector switches, and as a tester connector is provided in each of these groups, there will be 100 test connectors. Furthermore, since the test distributors have 100 contact sets and are directively controlled in both their vertical and rotary movements, all of these test connectors may be reached by way of the test distributors without any intervening switches.

With this general description of the telephone system which has been chosen for describing the utility and the operation of the various features of the invention, the operation of the circuits may now be explained in detail. For this purpose, it will first be assumed that the wire chief wishes to establish a connection with the line of substation A for the purpose of performing the usual routine tests on this line. The wire chief first inserts the plug P′ of the test cord C into the jack of a trunk to an idle test distributor. For the sake of simplicity, a single position wire chief's test desk has been assumed and it has also been assumed that the distributors accessible at the wire chief's desk are individual thereto.

When the plug P′ is inserted into the jack J^2, assuming the trunk terminating in this jack is idle and is the one selected for use by the wire chief, contacts 218 are closed, thereby closing a circuit which may be traced from ground by way of the closed springs 218, through the winding of relay 204, through the resistance 217 to battery. Relay 204 operates and prepares a point in the operating circuit for operating succeeding switches at armature 214, and prepares a holding circuit for itself which includes the winding of relay 203 at armature 215. Relay 203 is not operated at this time by reason of the ground on both ends of its winding. Another result of the insertion of plug P′ into jack J^2 is the establishment of a circuit which may be traced from ground by way of armature 38 and the resting contact, resistance 41, closed contacts 55, closed contacts 57, closed contacts 52, sleeve of plug P′, sleeve of jack J^2, through the winding of relay 201, through the upper winding of relay 202 to battery. Due to the resistance 41, the current flow at this time through relay 202 is insufficient to cause its operation. Relay 201 is energized, however, and by the operation of its armatures 206 and 208, the tip and ring conductors connected to the jack J^2, are disconnected from the operating circuit at the normally closed springs controlled by these armatures, and are connected to the testing conductors 223 and 224 at the working contacts of these armatures, respectively. A point in the supervisory circuit of the lamp L^2 is also opened at the resting contact of armature 206. At armature 207 and its working contact, a bridge is placed across the operating conductors 221 and 222. A circuit is thereby closed for the line relays 302 and 303 of the test distributor TD which may be traced from ground through the winding of the line relay 302, normally closed contacts controlled by armature 315, conductor 221, armature 207 and its working contact, normally closed springs controlled by armature 210, working contact and armature 214, conductor 222, normally closed springs controlled by armature 316, through the winding of the line relay 303 to battery. Relay 303 operates and closes a circuit for the release relay 304 at armature 319, and prepares the impulse repeating circuit, to be described later, at armature 320. Relay 302 operates and closes an alternate circuit for the release relay 304 at armature 318. The operation of armature 317 has no utility at this time. Release relay 304 operates and prepares the circuit for the operating magnets of the switch at armature 321 and its working contact, and prepares the energizing circuits for relays 307 and 309, to be described later, at armature 332 and its working contact.

The foregoing operations all take place responsive to the insertion of the plug P′ into the jack J^2. The circuits are now prepared to receive the impulses produced by the movement of the calling device S, when the wire chief dials the proper digits. When the calling device S is moved from its normal position by the setting operation of the dial, springs 19 are closed, thereby establishing a circuit from ground at these springs, through the winding of the slow acting relay 4 to battery. Relay 4 operates and closes a circuit for relay 32 in the test cord circuit from ground by way of the working contact at armature 14, through the winding of slow acting relay 32 to battery. The operations of armatures 13 and 15 performs no function at this time, provided the talking key in the cord circuit C is not operated, as will be assumed. Relay 32 operates and prepares a dialling circuit by bridging the calling device S and the polarized relay 5 across the tip and ring conductors of the test cord at armatures 37 and 39. At the resting contact of armature 38, ground potential is removed from the sleeve conductor, thereby opening the circuit for relay 201, and at the working contact of this armature a circuit is closed for the slow acting relay 31, the latter circuit including contacts 58. Relay 31 operates and at the resting contacts of armatures 35 and 36 disconnects the springs of the reversing key, designated REV, and all the remaining apparatus to the left of this key from the tip and ring conductors of the plug P′, and at the working contacts of these armatures places a shunt around armatures 37 and 39, the purpose of which will be explained subsequently. At present, the operation of armature 34 has no utility. The purpose of the resistance 42 is to prevent the lighting of the lamp L^1 at this time.

As soon as the circuit of relay 201 is opened, this relay deenergizes and by releasing its armatures 206 and 208 the tip and ring conductors of the jack J^2 are again connected to the operating conductors 221

and 222, respectively. The release of armature 207 opens the initial bridge across the operating conductors 221 and 222, so that the circuit for the line relays 302 and 303 now includes normally closed contacts controlled by armatures 206 and 208, tip and ring of jack J^2, tip and ring of plug P', contacts 51 and 52, armatures 37 and 39 and their working contacts in multiple with armatures 35 and 36 and their working contacts, respectively, polarized relay 5 shunted by the resistance 18, and the calling device S. The direction of the current flow in the polarized relay 5 at this time, however, is in such a direction as not to cause its operation.

The relay operations described in the immediate foregoing paragraphs take place responsive to the setting operation of the calling device. After the setting operation, the calling device is allowed to return to normal, thereby producing circuit interruptions or impulses, the number of such impulses corresponding to the digit at which the calling device was set, thus causing a corresponding number of deenergizations of the relays 302 and 303 in the test distributor. The first time the line relay 303 deenergizes, a circuit is closed which may be traced from ground at the armature 319 and its resting contact, armature 321 and its working contact, normally closed springs 339 through the winding of the slow acting series relay 305, through the winding of the vertical magnet 311 to battery. Vertical magnet 311 operates and raises the wipers 341–346, inclusive, opposite the first level of bank contacts, at the same time permitting the closure of the off normal contacts 339' and opening the contacts 339. Series relay 305 energizes and operates its armature 323. The next time the line relay 303 deenergizes, impulses of current are received by the vertical magnet over a circuit similar to the initial circuit, except that it now includes closed contacts 339' and armature 323 and its working contact, excluding contacts 339. Due to the slow acting characteristic of series relay 305, this relay remains operated during the sending of the remaining impulses of this digit. Each time the vertical magnet receives an impulse it operates to raise the switch wipers opposite the next level. In this manner, the wipers 341—346 are elevated step by step until they stand opposite the level of bank contacts corresponding to the first digit dialled by the wire chief. At the termination of the impulses of the first digit, relay 305 deenergizes and prepares a circuit for the rotary magnet 312 at armature 323 and its resting contact.

When the calling device returns to normal after the dialling of the first digit, springs 19 are again opened, thereby opening the circuit of the slow acting relay 4. Relay 4 deenergizes and by releasing its armature 14 opens the circuit for the slow acting relay 32. Relay 32 deenergizes. By releasing its armatures 37 and 39, the points at which the calling device was initially bridged across the tip and ring conductors of the test cord are opened. However, the bridge consisting of the calling device and the relay 5 and resistance 18 in parallel is still maintained across the tip and ring conductors at armatures 35 and 36. By the release of armature 38, ground is replaced on the sleeve conductor at the resting contact, and the circuit of the slow acting relay 31 is opened at the working contact of this armature. Relay 201 is energized and again places the holding bridge across the operating conductors 221 and 222 at armature 207, and again connects the tip and ring of jack J^2 to the test conductors 223 and 224 at armatures 206 and 208, respectively. Shortly after the deenergization of relay 32, which opens the circuit of the slow acting relay 31, relay 31 deenergizes and opens the bridge including the calling device S across the tip and ring conductors of the test cord C at armatures 35 and 36. By reason of the slow acting characteristic of relay 31, this bridge is not opened, however, until after relay 201 has operated to replace the holding bridge across the operating conductor at armature 207, and maintain the test distributor in an operated position.

The wire chief may now dial the second digit of the desired number. When the calling device S has moved off normal, the operations concerning relay 4, relay 32, relay 31, and relay 201 take place in the manner described previously. Relays 302 and 303 again deenergize a number of times corresponding to the digit dialled. At each deenergization of relay 303, an impulse of current is transmitted to the rotary magnet over a circuit which may be traced from ground by way of armature 319 and its resting contact, armature 321 and its working contact, springs 339', armatures 323 and its resting contact, resting contact and armature 331, armature 334 and its resting contact, through the winding of the rotary magnet 312 to battery. In response to the impulses of current transmitted to the rotary magnet 312, switch wipers 341–346, inclusive, are rotated step by step into engagement with the set of bank contacts corresponding to the digit dialled. The slow acting relay 306 energizes in multiple with the rotary magnet 312 and is maintained energized due to the slow acting characteristics throughout the entire rotary movement. In operating, relay 306 closes a circuit for the slow acting relay 307, which may be traced from ground by way of the working contact and armature 322, resting contact and armature 333, armature 325 and its working contact, through the winding of relay 307 to battery. Relay

307 operates and prepares the initial energizing circuit for the switching relay 309 at armature 328, and disconnects the heavy testing conductors 223 and 224 from the wipers 341 and 346 at armatures 326 and 330, respectively. Armature 324 of relay 306 and armature 327 of relay 307 have no utility at present. When the dial S again returns to normal at the termination of the sending of the impulses of the second digit, the operations concerning relay 4, relay 32, relay 31, and relay 201 take place as described hereinbefore, and the line relays 302 and 303 are again maintained energized. After an interval, relay 306 deenergizes and releases its armatures. It may be assumed that other operators have access to the test connectors by way of test distributors similar to test distributors individual to the wire chief and having their bank contacts multiplied thereto. If the test connector TC is busy at this time, i. e., is in use in some other connection by some other operator, ground potential will be present on the bank contact 353, since relays 361 and 362 will be in an operated position. Then, after the release of relay 306, a circuit is closed extending from the ground by way of working contact and armature 368, bank contact 353, private test wiper 343, armature 336 and resting contact, winding of busy relay 308, and through the winding of the slow acting relay 307 to battery. When relay 306 is in an operated position, ground potential is maintained on both terminals of the winding of relay 308. Busy relay 308 is prevented from operating until the release of slow acting relay 306 but operates before relay 32 in the test cord has had time to fall back. By the release of slow acting relay 306 this ground potential is removed from the upper terminal of relay 308. Relay 308 is then permitted to energize over the previously traced circuit, assuming the test connector TC is busy, at the same time maintaining relay 307 in an operated position. In operating, relay 308 opens a point in the initial energizing circuit of relay 309 at armature 333, opens the circuit of the rotary magnet 312 at armature 331, and closes a circuit for the reversing relay 301 at armature 332. Any further actuation of the calling device would not effect further operations since the circuit of the rotary magnet is open at armature 331. Relay 306 would be energized, operating its armature 325, but since armature 333 is operated, relay 308 is not short circuited. Thus, as long as ground remains on the contact 353, busy relay 308 will be maintained operated.

Relay 301 energizes over the previously traced circuit, and by the operation of its armatures 315 and 316 reverses the direction of current flow over the operating conductors 221 and 222 and through the polarized relay 5, causing this relay to operate. As a result of the operation of relay 5, the busy tone circuit is closed at armature 16 and the working contact which may be traced from the busy machine B, working contact and armature 16 through the uppermost winding of the induction coil M, through the receiver R, resting contact and armature 15, it being remembered the relay 4 deenergizes when the calling device returns to normal, resting contact and armature 12, condenser 29, armature 9 and the resting contact to ground. At armature 17 and the working contact a holding circuit is closed for relay 32 which includes contacts 59, working contact and armature 34, and resistance 42. The deenergization of relay 32, which would ordinarily take place a short time after the release of relay 4, is thereby prevented. The operation of armature 17 also closes a circuit for the lamp L^1, which includes normally closed contacts 59. The lighting of the lamp L^1 and the busy tone heard in the wire chief's receiver indicates to the wire chief that the test connector TC, individual to the group terminating the line to substation A, is busy.

While it is possible for the wire chief to wait on the line until the test connector TC becomes idle, he will in all probability remove the plug P′ from the jack J^2 and reinsert the plug into the jack of another trunk in preparation for testing lines in some other hundreds group. When the plug P′ is removed from the jack J^2, direct ground is removed from the upper terminal of the winding of relay 204 by the separation of contacts 218, thereby permitting the operation of relay 203 over a circuit from ground through the winding of relay 203, working contact and armature 215, through the winding of relay 204, resistance 217 to battery, at the same time maintaining relay 204 operated. Relay 203 energizes and places a holding bridge across the operating conductors 222 and 221 at armature 211. The operation of armatures 212 and 213 performs no useful function at this time. Removing the plug P′ from the jack J^2 also opens the circuit of relay 201. Relay 201 releases and restores its armatures to normal, removing the initial bridge at armature 207.

At a later time the wire chief may resume the testing of lines in the first one hundred group and he may reinsert the plug P^1 into the jack J^2. By the closure of springs 218 direct ground is again placed on the upper terminal of relay 204 again short circuiting relay 203. Relay 203 deenergizes and opens the holding bridge at armature 211. Relay 201 again energizes and closes the bridge at armature 207 and again operates armatures 206 and 208. Due to the short circuiting of relay 203 at this time, this re-

lay assumes a slow acting characteristic and therefore does not deenergize and open the bridge at armature 211 until the initial bridge has been closed at armature 207.

When the test connector becomes idle, which may have taken place before, or may take place after the plug P^1 is reinserted into the jack J^2, ground potential is removed from the test contact 353. The removal of ground from test contact 353 opens the circuit for relay 308 and relay 307. Relay 308 de-energizes and opens a circuit for the reversing relay 301 at armature 332, causing relay 301 to deenergize, and closes the initial energizing circuit for the wiper switching relay 309 at armature 333 and the resting contact, which may be traced from ground by way of the working contact and armature 322, resting contact and armature 333, armature 325 and the resting contact, armature 328 and the working contact, through the winding of relay 309 to battery. Relay 309 operates and opens another point in the circuit of the rotary magnet at armature 334, establishing a locking circuit for itself at armature 337 independent of armatures 333, 325, and 328; prepares the circuit for testing the subscriber's line for the busy or idle condition described more in detail later at armature 335; opens the test connector test circuit at armature 336; and closes the impulse repeating circuit for the test connector TC at armature 338, this circuit including armatures 338 and 320, wipers 344 and 345, bank contacts 354 and 355, and the upper and lower windings of the line relay 361. Line relay 361 operates, closing a circuit for the release relay 362 at armature 367. Relay 362 operates and places ground potential on the test contact 353 at armature 368 to guard this test connector against being seized by some other test distributor, and prepares the circuit for the vertical magnet 365 at armature 369. It is understood, of course, that had the test conector TC been idle initially, the busy relay 308 would not have operated and the wiper switching relay 309 would have operated immediately following the deenergization of the slow acting relay 306, with the same results as described above.

As a result of the deenergization of relay 301, direction of current flow over the operating conductors 221 and 222 is reversed back to normal, thereby causing the release of the polarized relay 5, assuming that the test plug P′ is in jack J^2. Release of armature 16 disconnects the busy tone and the release of armature 17 opens the holding circuit for relay 32 and causes the extinguishing of the lamp L^1. The deenergization of relay 32 causes the deenergization of relay 31, both relays releasing their armatures, with the result as described previously. The removal of the busy tone and the extinguishing of the lamp L^1 gives the wire chief indication that the test connector has been seized and that he may resume dialling the remaining digits of the required number.

Responsive to the impulses produced by dialling the third digit, the line relays 302 and 303 again deenergize correspondingly. Relays 306 and 307 are operated as previously described, but perform no useful function at this time. The circuit of the line relay 361, however, is opened each time the armature 320 falls back. Therefore, relay 361 deenergizes in synchronism with the deenergizations of the line relay 303. The first time relay 361 deenergizes, an impulse of current is transmitted to the vertical magnet 365 over a circuit which may be traced from ground by way of armature 367 and the resting contact, armature 369 and the working contact, normally closed springs 372 through the winding of the series relay 363, through the winding of the vertical magnet 365 to battery. In response to this energization of the vertical magnet 365, wipers 374—376 are raised opposite the first level of bank contacts. At the same time contacts 372 are opened and contacts 373 are permitted to close. The series relay 363 operates and prepares a circuit for the remaining impulses to the vertical magnet at armature 370 and the working contact. The remaining impulses to the vertical magnet now traverse a path similar to the path of the initial impulse, except that now contacts 373 and armature 370 and the working contact are included and contacts 372 are excluded. Due to its slow acting characteristics, relay 363 remains in an operated position during the transmission of this series of impulses. In response to these impulses, the switch wipers 374–376, inclusive, are raised step by step until they are opposite the level of bank contacts corresponding to the third digit dialled by the wire chief. At the termination of the dialling of the third digit, series relay 363 deenergizes and prepares a circuit for the rotary magnet 366 at armature 370 and the resting contact.

The wire chief may immediately dial the fourth digit or last digit of the number of the desired line. In response to the impulses produced by the dialling of the fourth digit, line relay 303 is again deenergized a corresponding number of times. Each deenergization of relay 303 causes a deenergization of the line relay 361. Each time armature 367 releases, an impulse of current is transmitted from ground by way of the armature 367 and the resting contact, armature 369 and the working contact, contacts 373, armature 370 and the resting contact, through the winding of the rotary magnet 366 to battery. In response thereto, the wipers 374—376 are rotated into engagement with the set of bank contacts terminating the line to substation A. If the line to substation A is busy at

this time, ground potential will be present on the private test contact 378 according to the well known method of marking a busy line. As previously described, slow acting relays 306 and 307 are energized during the impulsing periods. At armature 324 a point in the testing circuit of the subscriber's line is held open and at armature 327 another point in this circuit is closed. The testing conductors 323 and 324 are also maintained disconnected from the wipers 341 and 346 at armatures 326 and 330, respectively. At the termination of the impulses of the final digit, relay 306 deenergizes and, assuming the line to substation A is busy, a circuit is closed from the ground potential on bank contact 378, wiper 375, bank contact 352, wiper 342, armature 335 and the working contact, working contact and armature 327, armature 324 and the resting contact, through the winding of the reversing relay 301 to battery. Relay 301 operates and reverses the direction of current flow over the operating conductors 221 and 222, as described previously, and prepares a holding circuit for itself at armature 314 and the working contact. Shortly after the release of relay 306, relay 307 deenergizes and permits the closure of the contacts controlled by armature 327, thereby completing the holding circuit for the reversing relay 301, which circuit is similar to the initial circuit for this relay except that it includes armature 314 and the working contact and excludes armatures 324 and 327.

The reversal of the direction of current flow over the operating conductors again causes the operation of the polarized relay 5, which functions to connect the busy tone to the receiver circuit and causes the lighting of the lamp L^1 at the same time preventing the release of the relays 32 and 31. The lighting of the lamp L^1 and the audible busy tone indicate to the wire chief that a busy condition exists on the line with which he wishes connection. This busy condition may either be due to an established connection between this substation and some other substation, or it may be a false busy condition caused by any one of several conditions, such as a short circuit on the line or the grounding of a conductor of the line.

The next duty of the wire chief, is to verify this busy condition, which he does by throwing the listening key, designated TALK, and listening for conversation. By the closure of contacts 53 and 56, conductors 21 and 23 are connected across the tip and ring conductors of the test cord C, respectively. The separation of springs 59 opens the holding circuit for relay 32, and also opens a circuit for the lamp L^1. Relay 32 therefore deenergizes, opening the circuit of relay 31 which in turn deenergizes shortly thereafter. By the closure of springs 56, which causes the separation of springs 55, a circuit is again established for relay 201, which may be traced from ground by way of armature 13 and the resting contact, through the slow acting relay 3, normally closed contacts controlled by armature 8, conductor 22, closed contacts 56, contacts 57, contacts 52, sleeve of plug P', sleeve of jack J^2, through the winding of relay 201, and through the upper winding of relay 202 to battery. The resistance of the winding of relay 3 is approximately the same as the value of the resistance 41. Again relay 202 is not operated, but relay 201 is energized, operating its armatures 206 and 208, as previously described, and establishing a holding bridge at armature 207, for maintaining the succeeding automatic switches, namely, the test distributor TD and test connector TC, in an operated position. The deenergization of relay 31 which followed the release of relay 32 disconnects the bridge including the calling device S and relay 5.

Relay 3 operates over the above traced circuit and opens the receiver circuit at armature 12 and closes the circuit for relay 2 at armature 11. Relay 2 operates and closes a new circuit for relay 201 at armature 8 and the working contact by disconnecting the ground through the winding of slow acting relay 3 and substituting therefor ground through its own winding. The resistance of the winding of relay 2 is substantially the same as the value of resistance 41. Thus, the value of the current flow through the relay 201 still is maintained insufficient to cause the operation of relay 202. At armatures 7 and 9, the telephone set is connected across the conductors 21 and 23, connected to the tip and ring conductors of the test cord C, respectively, the receiver circuit finally being closed when the slow acting relay 3 deenergizes and releases its armature 12. By holding the receiver circuit open at armature 12 a short time after the operation of relay 2, condenser 29 is given sufficient time to become charged to the potential existing across the lines so that when the receiving circuit is finally closed, no annoying clicks will be heard in the receiver. This arrangement for preventing clicks in the receiver when keys are thrown, is more fully described in the inventor's copending application, Serial No. 53,025, filed August 28, 1925.

Since the telephone set is now connected across the tip and ring conductors of the test cord C, the wire chief will hear the talking of the subscribers engaged in conversation if the line is busy, due to an established connection. It may be assumed that the wire chief hears conversation. The wire chief may then either wait until the conversation has ceased and the subscribers have replaced their receivers and then commence the per-

formance of the tests which are to be made on the line, or he may withdraw the plug P′ from the jack J² and release the connection to the subscriber's line by depressing key K as will be described subsequently. It is assumed that the former procedure is chosen.

As soon as the line of substation A becomes idle, and the receiver thereat is replaced, the direct current bridge across the line conductors 391 and 392 to which the test conductors 223 and 224 are connected is opened, and the ground potential is removed from the private bank contact 378. As a result, the circuit for the reversing relay 301 is opened. Relay 301 deenergizes and reverses the current supply connections to conductors 221 and 222 back to normal and at armature 314 and the resting contact closes a circuit which may be traced from ground by way of the working contact and armature 317, resting contact and armature 314, springs controlled by armature 327, working contact and armature 335, wiper 342, private test contact 352, wiper 375, private test contact 378, through the winding of the bridge cut-off relay 382 of the line switch LS, interrupter springs 389, through the winding of magnet 383 to battery. The resistance of relay 382 is sufficiently high to prevent the operation of magnet 383 at this time. Relay 382 operates, however, and, due to a mechanical interlocking arrangement between relay 382 and relay 381, the armatures of relay 382 are permitted to break contact with their resting contacts but are not permitted to make contact with their working contacts. Thus, the line conductors 391 and 392 are disconnected from their normal battery and ground connections. Test contact 378, and the test contacts multiply connected thereto, are again at ground potential to prevent the line to substation A from being connected to by some other connector. When the wire chief is ready, he may commence the performance of the required tests on the subscriber's line.

If the line to substation A had been idle at the time the test connector wipers 374–376, inclusive, were rotated into engagement with the bank contacts 377–379, inclusive, the reversing relay would not have been operated and relay 382 of the line switch LS would have operated immediately following the deenergization of relay 307 of the test distributor TD. The wire chief would have received no busy signals and would have then been able to commence the testing operations immediately.

Had the wire chief heard no conversation after the listening key had been thrown, having been given the busy signals, he would have assumed that the busy condition was false and would have proceeded to make the necessary tests to determine the nature of this false busy condition and then make the necessary report or send a trouble man out to locate the trouble, according to the practice of the telephone company.

In such a case, if he wishes, he may withdraw the plug of the test cord from the jack without releasing the connection to the line in trouble. To describe the operations under such procedure, it will be assumed that the busy test was false, and after testing the nature of the trouble in the well known manner, the wire chief removes the plug P′ from the jack J². As previously described, withdrawing the plug P′ from the jack J² permits relay 203 to operate in series with relay 204, and causes the deenergization of relay 201. By the operation of relay 203, a holding bridge is placed across the operating conductors 221 and 222 at armature 211 and its working contact; ground potential is placed on the heavy testing conductor 223 at armature 212 and its working contact; and battery is placed on the heavy testing conductor 224 at armature 213 and its working contact through the lower winding of relay 202. Since it has been assumed that the called line tested busy, the existing trouble must either be a short circuit across the line conductors or a ground on the negative side. Relay 202, therefore, operates over its lower winding as soon as armatures 212 and 213 are operated. Relay 202, in operating, closes a circuit for the supervisory lamp L², which may be traced from ground by way of armature 212 and its working contact, armature 206 and its resting contact, armature 209 and its working contact, through the lamp L² to battery. The operation of armature 210 performs no useful function at this time. As long as the trouble on the line of substation A exists, lamp L² will be lighted. During this time, the wire chief may test other lines in some other hundred group or perform other duties as he chooses.

As soon as the trouble on the line is removed, the circuit of relay 202 is opened. In deenergizing, relay 202 opens the circuit of lamp L². The extinguishing of the lamp L² indicates to the wire chief that the trouble has been removed, whereupon he may resume the testing of the line when he is ready.

This invention is not particularly concerned with the performance of any new tests. It is, therefore, thought that a cursory explanation of the various keys shown and their functions will suffice. Only a few of the more common keys have been shown, but it is understood that the test cord may be provided with other key arrangements for performing other tests, as required. The connector release key, designated CONN RLSE, is provided for releasing the test connector without releasing the preceding

test distributor. When the CONN RLSE key is thrown, battery through a resistance is placed on the tip conductor at contacts 60, and ground is removed from the sleeve conductor at contacts 52. Relay 201 is thereby caused to deenergize and connects the tip and ring of the jack J^2 to the operating conductors 221 and 222, and removes the holding bridge at armature 207. These operations open the circuit for the line relay 303 of the test distributor TD which deenergizes and opens the circuit of the line relay 361 of the test connector TC at armature 320. Relay 302 remains energized, however, over a circuit which may be traced from ground through the winding of relay 302, normally closed contacts controlled by armature 315, conductors 221, normally closed contacts controlled by armature 206, tip of jack J^2, tip of plug P', closed contacts 60, through the resistance at the CONN RLSE key to battery. Relay 304 is maintained energized from ground by way of the working contact at armature 318, and the release circuit for the test distributor is maintained open at armature 321. The release of relay 361 opens the circuit of relay 362. With both relays 361 and 362 in a deenergized position, a circuit is closed for the release magnet 367, which operates to restore the test connector TC to normal.

The BCO key is provided to enable the wire chief to deenergize the bridge cut-off relay of the called line and permit the testing of the said line in the direction of the automatic switchboard. When the BCO key is operated, a point in the circuit for relay 31 is opened at contacts 58 and a locking circuit is prepared for relay 32 at contact 61. Direct ground is placed on the sleeve conductor at spring 62, at the same time disconnecting the ground connection to the sleeve which includes the resistance 41. Direct ground on the sleeve conductor permits sufficient current to flow through relays 201 and 202 to cause the operation of relay 202. Relay 202, by operating its armature 210 places ground potential on the operating conductor 222 by way of armature 212 and the resting contact, and opens a point in the bridge across conductors 221 and 222 at the springs controlled by armature 210. The circuit of relay 302 is thus opened. This relay deenergizes and removes ground from the private test conductor 393 at armature 317. Relay 303 is maintained operated from ground supplied to the operating conductor 222. By the removal of ground from the private test conductor 393, the circuit for the bridge cut-off relay 382 is opened. Relay 382 then deenergizes and permits the subscriber's line to be tested in the direction of the automatic switch board for normal battery and ground connections. A dialling test may also be made on the subscriber's line, maintaining the BCO key operated and dialling some other number. Relay 32 will operate as previously described, but in this case instead of releasing each time the calling device S returns to normal, relay 32 locks over a circuit from ground at armature 38 and the working contact, closed springs 61, through its winding to battery. Relay 31 is not operated since its circuit is opened at springs 58. Restoring the BCO key opens the locking circuit of relay 32 and restores the relay to normal.

The talking and listening key, designated TALK, has been described in connection with the setting up of the connection to the line to substation A. The function of the ringing key, designated RING, is obvious and needs no further explanation. The function of the battery cut-in key, designated BCI, is to supply talking current to the line and give supervision when a connection between the trouble man and the wire chief has been established over a trunk, such as the trunk terminating in the jack J^5. A connection of this kind will be described subsequently.

To test the subscriber's line for the presence of foreign battery, the ground key, designated GRD, is operated. With the GRD key operated ground is connected to one side of the volt meter V. The ring side of the line, remains connected to the other side of the volt meter V. If a foreign battery potential exists on the ring side of the line the volt meter V will be deflected. To test the other side of the line for foreign battery, the reversing key, designated REV, is thrown, in addition to the GRD key. Throwing the REV key reverses the tip and ring conductor connections with respect to the volt meter. In either case, if the volt meter deflection is in a reverse direction, the volt meter reverse key, designated VMR, is also thrown. This reverses the connection to the volt meter.

The ring side of the line may be tested for ground by operating the GRD key and either the high scale or the low scale volt meter key, designated HS and LS respectively. To test the tip side of the line for ground, the ground key GRD and the reverse key REV are thrown, in addition to either the low scale or high scale volt meter key. Other functions of the low scale key and the high scale key as shown in the drawings will suggest themselves to those skilled in the art, and need not be further described.

After the wire chief has performed the necessary tests on the line of substation A, he most probably will wish to perform similar tests on another line. The line that will probably be tested next is the line terminating in the next set of bank contacts in a same level in which the line of substation A

terminates, since the wire chief need dial only an extra digit 1 to establish connection with this next line. In response to the dialling an extra digit 1, a single impulse is produced, causing line relay 303 to deactuate momentarily, as described before, and open the circuit of the line relay 361 at armature 320. Relay 361 falls back and sends an impulse of current to the rotary magnet 365. Rotary magnet 365 operates to rotate the switch wipers 374–376, inclusive, into engagement with the next set of bank contacts. The wire chief may then test the line terminating in this set of bank contacts. The testing of this line for the busy or idle condition will take place in a manner identical to that in which the line to substation A was tested for the busy or idle condition. It is apparent then, that connection may be established with each line terminating in the same level of connector bank contacts, consecutively, by dialling another digit 1. To obtain connection with the line terminating in a different level of the bank contacts, the connector release key is operated, as described above, to release the connector TC and the last two digits of the directory number of the subscriber's line, to which connection is desired, are dialled.

The operations which are performed and which take place to release the entire connection may now conveniently be explained. The wire chief first withdraws the plug P′ from the jack J^2. As described previously, this operation permits relays 203 to operate in series with relay 204 to establish the holding bridge across the operating conductors 221 and 222 to armature 211. To release the entire connection, the wire chief operates the key K momentarily, which short circuits both relays 203 and 204. Both relays deenergize and allow their armatures to restore to normal. The removal of the bridge across the operating conductors at armature 211 opens the circuits for both relays 302 and relay 303. These relays fall back and open the circuit of relay 382 at armature 317 and open both circuits for the release relay 304 at armature 318 and armature 319. Upon the release of the relay 304, a circuit is closed which may be traced from ground by way of armature 319 and the resting contact, armature 321 and the resting contact, springs 340 which was closed upon the first vertical step of the switch wipers, through the winding of the magnet 310 to battery. Release magnet 310 operates and restores the switch wipers to normal. In deenergizing, relay 304 also opens the circuit of the wiper switching relay 309 at armature 322, thereby restoring the circuits of the test distributor TD to normal. Furthermore, when line relay 303 deenergizes, the circuit of line relay 361 is opened at armature 320. Relay 361 deenergizes and opens the circuit of the release relay 362. Upon the release of relay 362, a circuit is closed which may be traced from ground by way of armature 367 and its resting contact, armature 369 and its resting contact, springs 371, which are closed upon the first vertical step of the switch wipers, through the winding of the release magnet 364 to battery. Release magnet 364 operates to restore the switch wipers back to normal.

It will now be convenient to explain a certain function of the relay 4 in the telephone set TS, which heretofore has not been described and which makes it possible to operate the calling device with the talking key thrown without producing annoying clicks in the receiver. For the purpose of explaining this funtion, it may be assumed that the plug P′ has been inserted into the jack of some trunk terminating in the wire chief's position, and that the TALK key is thrown. Since there is battery potential on the sleeve of the jacks of the trunks teminating at the wire chief's position, relays 3 and 2 will have operated responsive to the throwing of the TALK key in a manner, as described previously, without producing any click in the operator's receiver. Now, when the calling device S is moved off normal, a circuit is closed for relay 4 from ground at the off normal springs 19. Relay 4 energizes and opens the receiver circuit at armature 15, and closes a circuit for relay 32 at armature 14, as previously described. By the operation of armature 13, ground is placed on the upper terminal of relay 2, thereby causing the deenergization of relay 2. In deenergizing, relay 2 disconnects the telephone set from across the test conductors. When the calling device returns to normal, the circuit of relay 4 is again opened at springs 19. Relay 4, thereupon deenergizes, closing a point in the receiver circuit at armature 15, and again closing the circuit for relay 3. Again the operations concerning relay 3 and relay 2 take place and the telephone set is connected across the tip and ring conductors of the test cord without the production of the usual annoying click in the receiver.

In a previous paragraph in this specification, it was mentioned that should the wire chief find a subscriber's line out of order, a trouble man may be sent out in the field to remove the trouble, after the nature of the trouble had been determined. It will now be assumed that the wire chief did not care to maintain connection with the line in trouble, and released the connection thereto as described above. It will further be assumed that the trouble man is out in the field and has made certain repairs upon a subscriber's line and now wishes to establish a talking connection with the wire chief. The trouble man will connect his telephone

set across the conductors of the line in question and dial a certain code number reserved for the wire chief. When the trouble man's telephone set is placed across the subscriber's line, the line switch individual to that line, which may be similar to the line switch shown in Fig. 3, is operated to hunt a trunk to an idle selector and prepare that selector for operation. By dialling the proper code, this selector and another selector are operated in the well known manner to select and connect with a trunk terminating at the wire chief's position, the latter selector contained in the group in whose banks the trunks terminating in the wire chief's position reserved for this special purpose are accessible. It is assumed that the trunk comprising conductors 523–525, inclusive, is the trunk selected. Responsive to a relay operation in the latter selector, a circuit is closed for relay 503 which extends from the bridge across the conductors 523 and 524, resting contacts and armatures 509 and 510, through the upper and lower windings of relay 503 to ground and battery, respectively. Relay 503 operates and closes a circuit for the line lamp L^5 at armature 512; connects a ring-back tone to conductor 524 at armature 513, supplied from the ring-back tone machine RB; and at armature 514 closes a circuit for the slow acting relay 504. Relay 504 operates and places ground on the private conductor 525 at armature 515 for the purpose of maintaining the previously operated selector switches associated with the connection in an operated position. A holding circuit for relay 501 is also prepared at armature 516.

In response to the lighting of the lamp L^5, the wire chief inserts the plug P′ of the test cord C into the jack J^5. The resistance of the upper winding of relay 501 and the winding of relay 502 are such that both these relays are energized over the circuit which may be traced from ground by way of armature 38 and its resting contact, resistance 41, contacts 55, contacts 57, contacts 52, sleeve of plug P′, sleeve of jack J^5, contacts 518 closed when the plug is inserted into the jack J^5, through the upper winding of relay 501, through the winding of relay 502 to battery. Relay 502 operates and disconnects the windings of relay 503, from the conductors 523 and 524, at armatures 509 and 510, respectively; and closes another circuit for relay 504 at armature 511. Relay 501 energizes and closes a locking circuit for itself at armature 507, which may be traced from ground by way of the working contact and armature 516, armature 507 and the working contact, through the lower winding of relay 501 to battery. The ring-back tone is disconnected from the line conductor 524 at armature 508, the circuit of line lamp L^5 is opened at armature 506 and the resting contact, and a circuit is prepared for the hold lamp L^6 at the working contact of this armature. Relay 503 deenergizes, maintaining the circuit of the hold lamp L^6 open at armature 512. The wire chief then operates the listening key, designated TALK, which initiates the operation of relays 3 and 2 to connect the telephone set TS across the testing conductors and also operates the BCI key to furnish a talking current supply for the transmitter of the trouble man's telephone set. The wire chief may now converse with the trouble man and receive such information or instructions, as might be given.

This trunk circuit is so designed that the wire chief may remove the plug P′ of the test cord C from the jack J^5, without releasing the connection, providing the trouble man's telephone set is still connected across the subscriber's line. In such a case, should the wire chief remove plug P′ from the jack J^5, the circuit including the upper winding of relay 501 and the winding of relay 502 will be opened. Relay 501 will be maintained energized, however, over the locking circuit including its lower winding. Relay 502 will deenergize and again connect the upper and lower windings of relay 503 to the conductors 523 and 524 at armatures 509 and 510 and their resting contacts, respectively. Relay 503 again operates and establishes the alternate circuit for relay 505 at armature 514 before it has had time to deenergize when its circuit is opened at armature 511. At armature 512, a circuit is closed for the hold lamp L^6. The lighting of this lamp indicates to the wire chief that the trouble man has not disconnected his telephone set from the subscriber's line. Should the wire chief again wish to establish a talking connection to the trouble man, he may reinsert the plug P′ into the jack J^5, thereby again causing the operation of relay 502, which in turn causes the deenergization of relay 503.

To release this connection, the wire chief again withdraws the plug P′ from the jack J^5, which causes the deenergization of relay 502, as described above. Again relay 502 is connected across the trunk lines 523 and 524. When the trouble man disconnects the telephone set from across the subscriber's line, relay 503 also deenergizes. With both relays 502 and 503 in a deenergized position, the circuit of relay 504 is opened. Relay 504 deenergizes and opens the locking circuit for relay 501 at armature 516 and removes ground from the private conductor 525 at armature 515. The removal of ground from conductor 525 causes the release of the succeeding selector switches in the well known manner. Relay 501 deenergizes, placing the trunk circuit in its normal condition.

The wire chief's position is also provided

with a trunk for general incoming and outgoing service. Should the wire chief wish to establish an ordinary connection to some other substation, he will insert the plug P′ of the testing cord into the jack J⁴, at which the trunk in question terminates. Inserting the plug P′ into the jack J⁴, closes a circuit for relay 401 from ground at springs 418 through the upper winding of relay 401 to battery. Relay 401 operates and at armature 406 opens a point in the circuit over which relay 402 is later to be held operated; connected the conductor 424 to the ring of jack J⁴ at armature 408; and at armature 407 and the working contact, closes a circuit which may be traced from ground by way of armature 38 and its resting contact, resistance 41, contacts 55, contacts 57, contacts 52, sleeve of plug P′, sleeve of jack J⁴, through the lower winding of relay 401, working contact and armature 407, through the winding of relay 402 to battery, at the same time opening a point in the circuit of the lamp L⁴ at the resting contact of this armature. Relay 402 operates and prepares a point in its holding circuit at armature 409; prepares a point in the circuit of the lamp L⁴ at armature 410; and closes a holding bridge across the conductors 423 and 424 at armature 411. By virtue of this bridge placed across the line conductors 423 and 424, the line switch individual to this trunk line is caused to operate and select a trunk to an idle selector switch in the well known manner. At armature 412, a shunt is placed around armature 409 for a purpose to be described later.

The circuit is now prepared for the operation of the calling device according to the number of the substation with which connection is desired. When the calling device is moved off normal, relays in the test cord operate, as previously described, to remove ground from the sleeve conductor, thereby opening the circuit of relay 402. Relay 402 deenergizes and at this time functions to open the holding bridge across the conductors 423 and 424 at armature 411, thus permitting the impulses produced by the calling device to be transmitted over the conductors 423 and 424 to operate the automatic switches in the exchange. When the calling device S returns to normal, relay 4 is deenergized which in turn opens the circuit of relay 32. When relay 32 deenergizes, the circuit of relay 31 is opened and ground is again placed on the release conductor, again closing the circuit for relay 402. Relay 402 operates and again places the holding bridge across the conductors 423 and 424 at armature 411, this taking place before relay 31 has had time to deenergize and disconnect the bridge including the dial S across the operating conductors. In response to the digits dialled by the wire chief, the automatic switches are operated in the well known manner to extend the connection to the desired substation, the last switch functioning to signal subscriber and finally complete the talking connection when the subscriber removes his receiver to answer the call. The wire chief then holds conversation with the called subscriber.

At the termination of the conversation, the called subscriber will replace his receiver and the wire chief will remove the plug P′ from the jack J⁴. Removing the plug P′ from the jack J⁴ opens the circuit for the upper winding of relay 401 by permitting the separation of springs 418, and opens the circuit for relay 402, including the lower winding of relay 401. Relay 402 deenergizes and at armature 411 opens the bridge including the winding of relay 403 across the conductors 423 and 424. As a result, the automatic switches associated with the connection are released in the well known manner. At armature 412, a point in the alternate circuit for relay 402 is opened. Relay 401 deenergizes, releasing its armatures and disconnecting conductor 424 from the sleeve of the jack J⁴ at armature 408. The energizing circuit for relay 402 includes the lower winding of relay 401 for the purpose of preventing relay 401 from deenergizing until after the circuit of relay 402 has been opened. This prevents relay 401 from falling back before relay 402 and also relay 403 have released their armatures, thereby preventing relay 402 from becoming locked in an operated position from ground at armature 406. The replacement of the receiver at the called substation initiates the release of the final connector switch, as is well known in the art.

Calls may also be extended to the wire chief over the trunk line comprising conductors 423 and 424 by dialing the number assigned to the wire chief for general service, this trunk line being accessible at the connector bank contacts 433 and 434, or multiples thereof. To establish such a connection, the subscriber removes his receiver and dials the number assigned to the wire chief for general service. In response to the removal of the receiver and the dialling of this number, automatic switches will be operated, the final switch operating to extend the connection to the bank contacts 433 and 434 and apply signalling current thereto. In response to this signalling current, relay 403, which is bridged across the conductors 423 and 424 in series with the condenser 417, will energize and close a circuit for relay 402 at armature 412. Relay 402 will energize and close a locking circuit for itself at armature 409; and close a circuit for the line lamp L⁴, which may be traced from ground at the resting contact and armature 406, armature 409 and the working contact,

armature 407 and its resting contact, working contact and armature 410, through the line lamp L^4 to battery. At armature 411, a bridge which is later to be closed across the conductors 423 and 424 is prepared.

In response to the lighting of the lamp L^4, the wire chief inserts the plug P′ into the jack J^4. Inserting the plug P′ into the jack J^4, results in the closure of the circuit for the upper winding of relay 401 at the springs 418, and in the preparation of an alternate circuit for relay 402, including lower winding of relay 401. Relay 401 energizes and actuates its armatures. At armature 407, a circuit is closed for relay 402, including the lower winding of relay 401, this circuit having been previously traced in connection with the previously described connection, it being closed before the initial circuit for relay 402 is opened at armature 406. Relay 402, therefore, remains operated. At armature 408, conductor 424 is connected to the sleeve of jack J^4, thereby also placing the direct current bridge across the conductors 423 and 424, which includes the winding of relay 403 and the working contact and armature 411. The placing of this direct current bridge across the conductors 423 and 424 causes the operation of a relay in the connector switch which disconnects the signalling current and finally completes the talking connection. Conversation between the calling subscriber and the wire chief may then be engaged in, and, at the end of the conversation, the release of the automatic switch and the restoration of the relays in the wire chief's telephone set and the relays in the trunk circuit, namely, relays 407, 402, and 403, takes place in the manner described above.

In small telephone systems, as suggested in the first paragraphs of the specification, the operator at the wire chief's position may be required to perform the duties, not only of a wire chief, but may also be required to perform the duties ordinarily assigned to a so-called "zero" operator. A special group of trunks may be provided, terminating at the wire chief's position for this kind of service. The trunk line comprising conductors 671–673, inclusive, terminating in the jack J^6, is one of this group of trunks, connection with which is obtained by dialling the digit 0. This trunk, therefore, is accessible in the tenth level of the first selector switch banks. Should a subscriber have difficulty in completing some certain connection, he would make a report of this fact by replacing his receiver and again removing it and dialling the digit 0 and inform the operator answering accordingly. In the present assumed case, the wire chief would answer the call, would determine the number of the subscriber with which the calling subscriber wishes a connection, and would then proceed to extend the desired connection by dialling the desired number for the calling subscriber, all this being done by means of the single ending cord SC, shown in Fig. 6.

It may be assumed then, that a certain subscriber has had difficulty in obtaining connection with a certain other subscriber and after replacing his receiver, he removes it the second time and dials the digit 0 to inform the "zero" operator of his difficulty. In response to the second removal of the receiver and the dialling of the digit 0, a first selector switch operates to select an idle trunk which, it will be assumed, is the trunk terminating in the jack J^6. By reason of the direct current bridge across the subscriber's line conductors at the subscriber's substation, the line conductors now being connected to the trunk conductors 671 and 673, a circuit is closed for relay 652 which includes the conductors 671 and 673 and the upper and lower windings of the relay 652. Relay 652 operates and connects the ring-back tone current to conductor 671 at armature 659, conductor 530 being connected to the ring-back tone machine RB, Fig. 5. The ring-back tone heard by the calling subscriber assures him that the connection has been extended to an operator's position. At armature 660, a circuit is closed for the call lamp L^7, which may be traced from ground by way of the working contact and armature 660, armature 657 and its resting contact, through the lamp L^7 to battery. At armature 661, a circuit is closed for the slow acting relay 653. Slow acting relay 653 operates and closes a circuit for the second slow acting relay 654 at armature 662, and places ground potential on the private conductor 672 at armature 663 for the purpose of holding the preceding switches in an operated position. Relay 654 operates, actuating its armature 664. The function of relay 654 will become obvious from the description of later operations.

In response to the lighting of the lamp L^7, the wire chief, who is now acting in the capacity of a "zero" operator, inserts the plug P^6 into the jack J^6 and throws the key, designated TALK′, for listening. As a result of the former operation, a circuit is closed for the upper winding of relay 651, which may be traced from ground by way of armature 607 and its resting contact, contacts 611, resistance 610, sleeve of the plug P^6, sleeve of jack J^6, contacts 665, which are mechanically closed when the plug P^6 is inserted into the jack J^6, through the upper winding of relay 651 to battery. Relay 651 operates and disconnects the ring-back tone from conductor 671 at armature 656; closes a holding circuit for its lower winding at armature 657, which may be traced from ground by way of the working contact and armature 660, armature 657 and the working contact, through the lower winding of relay

651 to battery, at the same time disconnecting the circuit of the lamp L^7 at the resting contact of this armature. An alternate ground connection which is later to be applied to conductor 672 is prepared at armature 658. It will be seen that relay 602 in the cord SC can not operate at this time by reason of the ground on both terminals of its winding. Throwing the TALK' key bridges the conductors 21' and 23' across the tip and ring conductors of the single ending cord SC. A circuit is also closed for relay 3 in the wire chief's telephone set, which may be traced from ground by way of armature 13 of the resting contact, winding of relay 3, normally closed contacts controlled by armature 8, conductor 22, conductor 22', contacts 618, sleeve of plug P^6, sleeve of jack J^6, contacts 665, through the upper winding of relay 651 to battery. Relay 3 operates and causes the operation of relay 2, this latter relay operating to connect the telephone set TS across the conductors 21 and 23 connected to conductors 21' and 23' in the hereinbefore described manner, this taking place without the production of an annoying click in the receiver R. The wire chief may then converse with the calling subscriber, and after learning his difficulty and the number with which he desires connection, he informs the calling subscriber that he will attempt to complete the connection for him. The wire chief then throws the key, designated DIAL, for dialling, and dials the number of the called subscriber. Operating the DIAL key disconnects direct ground from the lower terminal of relay 602. Relay 602 then operates over a circuit from ground through its own winding, resistance 610, sleeve of plug P^6, sleeve of jack J^6, contacts 665, through the upper winding of relay 651 to battery. At armature 607, a circuit for the supervision lamp L^8 and for the lower polarizing winding of relay 601 is closed. By the separation of contacts 614 and contacts 612 and by the closure of contacts 613 and contacts 619, the tip and ring conductors of the plug P^6 are disconnected from the outgoing conductors 621' and 622' and the calling device S and the polarized relay 5 are bridged across the conductors 621' and 622'. As a further result of the operation of relay 602, conductors 621' and 622' are connected to the outgoing trunk conductors 621 and 622, respectively. By reason of the direct current bridge, including calling device S and relay 5, now across conductors 621 and 622, the line switch terminating the conductors 621 and 622 and individual thereto, is caused to operate and select a trunk to an idle selector switch and prepare that switch to receive the impulses of a first digit dialled by the wire chief. At contacts 615 direct battery is placed on conductor 26', thereby preventing the operation of relay 32 when ground is connected to conductor 26 by the operation of relay 4 responsive to the movement of the calling device S off normal.

In response to the digits dialled by the wire chief, the selector switch mentioned above and other switches respond thereto to extend the talking connection, the last switch being a connector switch which operates to extend the connection to the called subscriber's line; signals the calling subscriber; and finally completes the talking connection when the called subscriber removes his receiver, as is well known in the art. When the wire chief has completed the dialling of the wanted subscriber's number, he restores the DIAL key to normal. In so doing, polarized relay 601 is bridged across the conductors 621 and 622 in series with the retardation coil 603 at contact 612, relay 608 now being operated. This bridge serves to hold the automatic switches associated with the connection between the called substation and the wire chief's position in an operated position. Current now flows through the upper winding of relay 601 in series with the retardation coil 603 from a current supply in the connector switch. The direction of this current flow, however, is opposite to that necessary to cause the operation of relay 601. Relay 601, therefore, remains inoperative at present.

In response to the removal of the receiver at the called substation, a relay operation in the connector switch takes place, which reverses the current flow over the trunk conductors 621 and 622 and through the winding of relay 601. This results in the operation of relay 601 which disconnects the circuit of the lamp L^8 at armature 605. The extinguishing of the lamp L^8 indicates to the wire chief that the called subscriber has answered. As soon as the called subscriber removes his receiver, the connection between this subscriber and the calling subscriber is in condition for conversation, the talking connection extending from the called subscriber through the automatic switches which were operated in response to the dialling by the wire chief, conductors 621 and 622, armatures 606 and 608 and their working contacts, conductors 621' and 622', contacts 614 and 612, tip and ring of jack J^6, condensers 666 and 667, conductors 671 and 673, through the automatic switches associated with the extension of the call to the wire chief's position from the calling substation.

As described in the above parapraphs, it was assumed that the TALK' key and DIAL key were separate keys and that each could be operated independent of the other. In this case, then, the TALK' key might be operated when the DIAL key is actuated and the wire chief dials a number. Again relay 4 has the function of initiating operations

that disconnect the telephone set TS from the heavy talking leads when the dial is off normal, to prevent disagreeable clicks in the receiver during dialling. It is the usual practice, however, to employ a double throw key arrangement for the dialling and talking controls, having the three alternate positions, forward, backward, and neutral, the neutral being its normal position, one of the other positions for dialling, and the other for talking, then, it is impossible to have both the dial and the talking spring arrangements operated at the same time. Consequently, relay 4 would perform no useful function in that case, when using the cord SC.

At the termination of the conversation, both subscribers will replace their receivers. Replacing the receiver at the called substation causes a deenergization of a certain relay in the connector switch associated with the connection to again reverse the current flow over the conductors 621 and 622 through the winding of relay 601 back to normal. Relay 601 then deenergizes, again closing the circuit for the lamp L^8 at armature 605. Replacing the receiver at the calling substation opens a bridge across the trunk conductors 671 and 673, thereby opening the circuit of the line relay 652. Relay 652 deenergizes and opens the locking circuit for relay 651 at armature 660, and opens the circuit for the slow acting relay 653 at armature 661. Relay 653 deenergizes and removes ground from the private conductor 672 at armature 663, and also opens the circuit for the second slow acting relay 654 at armature 662. The removal of ground from the private conductor 672 allows the release of the automatic switches operated by the calling subscriber when the connection was extended to the wire chief's position. Shortly after the deenergization of relay 653, relay 654 deactuates and again places ground on the private conductor 672 at armature 664 and its resting contact. Ground on this conductor now prevents the trunk line comprising conductors 671–673, inclusive, from being seized in the establishment of another connection to the wire chief's position at this time. The lighting of the lamp L^6 gives the wire chief indication that the subscribers have completed their conversation and that the called subscriber has replaced his receiver, whereupon the wire chief removes the plug P^6 from the jack J^6. This operation opens the circuit of relays 602 and relay 651 in series, causing their deenergization. By the release of the armatures of these relays, the circuits are again restored to normal.

The invention, its utility and operation, having been described what is considered new and is desired to have protected by Letters Patent is set forth in the appended claims.

What is claimed is:

1. In a telephone system, a cord circuit, a calling device normally disconnected from said cord circuit, means responsive to each movement of said calling device from its normal position for bridging said calling device across the talking conductors of said cord circuit while said calling device is in an off-normal position, and separate means for maintaining said calling device bridged across said talking conductors an interval after it returns to normal.

2. In a telephone system, a trunk line extending to an automatic switch, a cord circuit adapted to be connected to said trunk line, a calling device normally disconnected from said cord circuit, means responsive to the connecting of said cord circuit with said trunk line for placing a bridge across said trunk line exclusive of the conductors of said cord circuit to prepare said automatic switch for operation, and means responsive each time said calling device is moved from its normal position for opening said bridge and for bridging said calling device across the conductors of said cord circuit to place said automatic switch under the control of said calling device.

3. In a telephone system, a trunk line extending to an automatic switch, a cord circuit adapted to be connected to said trunk line, a calling device normally disconnected from said cord circuit, means responsive to the connecting of said cord circuit with said trunk line for placing a bridge across said trunk line to prepare said automatic switch for operation, connecting means responsive to the movement of said calling device from its normal position for connecting said calling device across the conductors of said cord circuit, and means individual to said trunk line and controlled by said connecting means for opening said bridge to place said automatic switch under the control of said calling device, said last means arranged to replace said bridge across said trunk line to hold said automatic switch operated when said calling device returns to normal after it has been moved from its normal position to effect the operation of said automatic switch.

4. In a telephone system, a cord circuit, an operator's telephone set, a calling device normally disconnected from said cord circuit, a key, contacts controlled by said key, means responsive to the closure of said contacts for connecting said telephone set to said cord circuit, and means responsive to each setting operation of said calling device for disabling said first means and for bridging said calling device across the conductors of said cord circuit while said calling device is in an off normal position.

5. In a telephone system, a cord circuit, an operator's telephone set, a calling device

normally disconnected from said cord circuit, means operative responsive to the actuation of a key for connecting said telephone set to said cord circuit, means responsive to a setting operation of said calling device for restoring said first means to disconnect said telephone set from said cord circuit and for connecting said calling device to said cord circuit, said last means adapted to permit the re-operation of said first means and to again disconnect said calling device from said cord circuit when said calling device returns to normal following the setting operation.

6. In a telephone system, a trunk line extending to an automatic switch, a cord circuit adapted to be connected to said trunk line, a calling device normally disconnected from said cord circuit, means individual to said trunk line and responsive to the connecting of said cord circuit to said trunk line for placing a bridge across said trunk line to prepare said automatic switch for operation, means responsive to the setting operation of said calling device for bridging said calling device across the conductors of said cord circuit and for removing said bridge thereafter to permit said calling device to control the operation of said automatic switch, and for again replacing said first bridge and then disconnecting said calling device from said cord circuit after said calling device has returned to normal to maintain said automatic switch operated.

7. In a telephone system, a trunk line terminating at an operator's position and permanently connected to an automatic switch, said trunk line also accessible in the banks of a second automatic switch, means for operating said second automatic switch to connect with said trunk line, a relay bridged across said trunk line in series with a condenser, said relay being operative responsive to signalling current from said second automatic switch for signalling the operator on incoming calls, and means for bridging said relay across said trunk line exclusive of said condenser for preparing said first automatic switch for operation on outgoing calls from the operator's position.

8. In a telephone system, a cord circuit, a calling device, a telephone set adapted to be connected to said cord circuit by the actuation of a key, relays operative responsive to the actuation of said key for preventing clicks in the receiver of said telephone set when said telephone set is connected to said cord circuit, and means responsive to a setting operation of said calling device for restoring said relays and for permitting their re-operation when said calling device returns to normal.

9. In a telephone system, a cord circuit, a calling device, a telephone set, means for bridging said telephone set across the conductors of said cord circuit, means operative responsive to the operation of said first means for preventing clicks in the receiver of said telephone set when said first means is operated, and means responsive to a setting operation of said calling device for restoring said second means and for causing the re-operation thereof when said calling device returns to normal.

10. In a telephone system, a cord circuit, a calling device, a telephone set, means for bridging said telephone set across the conductors of said cord circuit, means operative responsive to the operation of said first means for preventing clicks in the receiver of said telephone set when said first means is operated, and means responsive to a setting operation of said calling device for temporarily substituting said calling device for said telephone set and for restoring said second means, said second means again being operative when said calling device returns to normal.

11. In a telephone system, a trunk line terminating in a jack, a cord circuit terminating in a plug adapted to be inserted into said jack, a telephone set adapted to be bridged across the conductors of said cord circuit by the operation of a key, relays responsive to the actuation of said key providing said plug is in said jack and responsive to the insertion of said plug into said jack providing said key is actuated for preventing clicks in the receiver of said telephone set produced by either operation, a calling device, means responsive to a setting operation of said calling device for temporarily substituting said calling device for said telephone set, and means for restoring said relays to normal condition when the substitution is made so that the said relays are enabled to again perform their function when the said telephone set is again connected.

12. In a telephone system, a trunk line, a relay and a key individual to said trunk line, a shunt circuit around said relay, contacts controlled by said key when actuated for opening said shunt circuit, a circuit for energizing said relay when the shunt is opened, a calling device bridged across said trunk responsive to the actuation of said key, contacts in said shunt circuit opened by said relay whereby the relay is maintained energized after the key is restored, and a second bridge closed across the trunk line through contacts of said relay when the said key is restored.

13. In a telephone system, a trunk line comprising operating conductors and talking conductors, a cord circuit temporarily connected to the talking conductors of said trunk line, a calling device, means responsive to a setting operation of said calling device for connecting said calling device to

said cord circuit and for temporarily transferring the connection of said cord circuit from said talking conductors to said operating conductors.

14. In a telephone system, a trunk line comprising operating leads and test leads, a cord circuit temporarily connected to the test leads of said trunk line, a calling device, means responsive to a setting operation of said calling device for bridging said calling device across the conductors of said cord circuit, and means responsive to said first means for disconnecting said cord circuit from said test leads and connecting it to said operating leads.

15. In a telephone system, a trunk line having operating leads and test leads, a cord circuit temporarily connected to the test leads of said trunk line, a telephone set temporarily bridged across the conductors of said cord circuit, a calling device, and means responsive to a setting operation of said calling device for substituting said calling device for said telephone set and for substituting said operating leads for said test leads.

16. In a telephone set, a trunk line having operating leads and test leads, a cord circuit temporarily connected to the test leads of said trunk line, a telephone set temporarily bridged across the conductors of said cord circuit, a calling device, means responsive to a setting operation of said calling device for substituting said calling device for said telephone set, and means responsive to the actuation of said first means for substituting said operating leads for said test leads.

17. In a telephone system, a trunk line having operating leads and test leads, a cord circuit temporarily connected to the test leads of said trunk line, a telephone set temporarily bridged across the conductors of said cord circuit, a calling device, means responsive to a setting operation of said calling device for substituting said calling device for said telephone set, and means controlled over the sleeve conductor of said cord circuit for substituting said operating leads for said test leads.

18. In a telephone system, a trunk line comprising operating leads and test leads, a cord circuit temporarily connected to the test leads of said trunk line, a calling device, means responsive to a setting operation of said calling device for bridging said calling device across the conductors of said cord circuit, means responsive to said first means for disconnecting said cord circuit from said test leads and connecting it to said operating leads, and means for disabling said last means at will so that when the setting operation is performed the said cord circuit will not be disconnected from the test leads.

19. In a telephone system, a trunk line having operating leads and test leads, a cord circuit temporarily connected to the test leads of said trunk line, a telephone set temporarily bridged across the conductors of said cord circuit, a calling device, means responsive to a setting operation of said calling device for substituting said calling device for said telephone set, means responsive to the actuation of said first means for substituting said operating leads for said test leads, and means in said cord circuit for disabling said last means at will to prevent said last substitution when said setting operation is performed.

20. In a telephone system, a trunk line having operating leads and test leads, a cord circuit temporarily connected to the test leads of said trunk line, a telephone set temporarily bridged across the conductors of said cord circuit, a calling device, means responsive to a setting operation of said calling device for substituting said calling device for said telephone set, means controlled over the sleeve conductor of said cord circuit for substituting said operating leads for said test leads, and means in said cord circuit operable at will for disabling said last means to prevent said last substitution when said setting operation is performed.

21. In a telephone system, a trunk line terminating in an automatic switch, a cord circuit adapted to be connected to said trunk line, a first and a second relay individual to said trunk line, and means for operating said first relay for preparing the operating circuit of said automatic switch when said cord circuit is connected to the trunk line, and for operating said second relay in series with said first relay for maintaining said switch operated when said cord circuit is disconnected from said trunk line.

22. In a telephone system, a trunk line terminating in an automatic switch, a cord circuit adapted to be connected to said trunk line, a first and a second relay individual to said trunk line, means for operating said first relay for preparing the operating circuit of said automatic switch when said cord circuit is connected to the trunk line, and for operating said second relay in series with said first relay for maintaining said switch operated when said cord circuit is disconnected from said trunk line, and means operable at will for releasing both said relays to release said automatic switch.

23. In a telephone system, a trunk line comprising operating conductors and test leads and terminating in an automatic switch, a cord circuit adapted to be connected to said trunk line, means operable when said cord circuit is connected to said trunk line for closing a bridge across said operating conductors to prepare said automatic switch for operation, means for operating said automatic switch to effect the con-

nection of said test leads with a subscriber's line, a holding bridge and a supervisory bridge, means responsive to the disconnection of said cord circuit from said trunk line for substituting said holding bridge for said first bridge and for closing said supervisory bridge across the test leads of said trunk line, a supervisory relay included in said supervisory bridge, and means for operating said relay when said cord circuit is connected to said trunk line to open said first bridge.

24. In a telephone system, a trunk line terminating in an automatic switch, a cord circuit adapted to be connected to said trunk line, a bridge placed across said trunk line when said cord circuit is connected to said trunk line to prepare said automatic switch for operation, a calling device and relays individual to said cord circuit and to said trunk line, respectively, and operative each time said calling device is moved off normal for substituting said calling device for said first bridge, thereby placing said automatic switch under the control of said calling device.

25. In a telephone system, a cord circuit, a telephone set temporarily connected across the conductors of said cord circuit, a calling device, bridging means responsive to a setting operation of said calling device for bridging said calling device across the conductors of said cord circuit, means responsive to said bridging means for disconnecting said telephone set from the conductors of said cord circuit, and means in said cord circuit for disabling said last means at will.

26. In a telephone system, a cord circuit, a calling device, bridging means responsive to each setting operation of said calling device for bridging the same across the conductors of said cord circuit while the same is in an off normal position, and means operative at will for making said bridging means self-locking so that said calling device will be permanently bridged across the conductors of said cord circuit responsive to the next setting operation thereof.

27. In a telephone system, a cord circuit ending in a plug, a jack for receiving said plug, a telephone set adapted to be connected to said cord circuit by the actuation of a key, relays responsive to the actuation of said key for preventing clicks in the receiver of said telephone set when said key is actuated, and responsive to the insertion of said plug into said jack for preventing clicks in the receiver of said telephone set providing said key is actuated before said plug is inserted into said jack.

28. In a telephone system, a cord circuit, a called line, means including said cord circuit for extending a connection to said line, a calling device for controlling the setting up of said connection, bridging means responsive to each setting operation of said calling device for bridging said calling device across the conductors of said cord circuit while the same is in an off normal position, means for testing the called line, and means for locking said calling device across the conductors of said cord circuit responsive to said last means providing said called line tests busy.

29. In a telephone system, a cord circuit, a called line, means including said cord circuit for extending a connection to said line, a calling device for controlling the setting up of said connection, bridging means responsive to each setting operation of said calling device for bridging said calling device across the conductors of said cord circuit while the same is in an off normal position, means for testing the called line, means for locking said calling device across the conductors of said cord circuit responsive to said last means providing said called line tests busy, a telephone set, and means for substituting said telephone set for said calling device.

30. In a telephone system, an automatic switch, a first and a second line, a calling device, means responsive to each setting operation of said calling device for placing said switch under the control of said calling device while the same is off normal, and means in said switch responsive to one sending operation of said calling device for operating said switch to establish a connection with said first line, and responsive to a subsequent sending operation of said calling device for operating said switch to open said first connection and establish a connection with said second line.

31. In a telephone system, a cord circuit, an automatic switch temporarily connected with said cord circuit, a calling device normally disconnected from said cord circuit, means responsive to each setting operation of said calling device for connecting said calling device to said cord circuit and for placing said switch under the control of said calling device while the same is off normal, and means in said switch responsive to one sending operation of said calling device for operating said switch to establish a connection with said first line, and responsive to a subsequent sending operation of said calling device for operating said switch to open said first conection and establish a connection with said second line.

32. In a telephone system, a cord circuit temporarily connected to a trunk line, a telephone set temporarily connected to said cord circuit, a first branch normally connected to said trunk line, a second branch normally disconnected from said trunk line, an automatic switch in which each of said branches terminates a calling device, means responsive to a setting operation of said

calling device for substituting said calling device for said telephone set, and for substituting said second branch for said first branch.

33. In a telephone system, a cord circuit having talking conductors terminating in a plug, a telephone set temporarily connected across said talking conductors, a trunk line terminating in a jack, a first branch normally connected to said trunk line, a second branch normally disconnected from said trunk line, means responsive to the insertion of said plug into said jack for substituting said second branch for said first branch, a calling device, means in said cord circuit responsive to a setting operation of said calling device for substituting said calling device for said telephone set, and for disabling said first means to reconnect said normally connected branch to said trunk line.

34. In a telephone system, a trunk line comprising operating conductors and talking conductors terminating in a jack, a cord circuit ending in a plug, means responsive to the insertion of said plug into said jack for placing a bridge across said operating conductors, and responsive to the removal of said plug from said jack for opening said bridge, for placing a short-circuiting bridge across said operating conductors, and for placing a bridge including a supervisory relay across said talking conductors, and means for operating said relay while said plug is in said jack for opening said first bridge.

35. In a telephone system, a trunk line comprising operating conductors and talking conductors terminating in a jack, a plug ending in the cord circuit, means responsive to the insertion of the plug of the cord into said jack for placing a bridge across said operating conductors, and responsive to the removal of said plug from said jack for opening said first bridge, for placing a short-circuiting bridge across said operating conductors, and for placing a bridge including one winding of a double wound supervisory relay across said talking conductors, and a circuit including the sleeve of said jack for energizing said relay over the other winding to open said first bridge.

36. In a telephone system, a cord circuit, an operator's telephone set, a calling device, a key, self-locking means operative when said key is operated, providing said calling device is at normal, for connecting said telephone set to said cord circuit, and means responsive to the operation of said calling device for unlocking said self-locking means to cause said telephone set to be disconnected from said cord circuit while said calling device is off normal.

37. In a telephone system, a trunk line terminating in a jack, a plug ending cord, a telephone set, self-locking means responsive under certain conditions to the insertion of the plug of said cord into said jack for connecting said telephone set to said cord circuit, a calling device and means responsive to the operation of said calling device for unlocking said self-locking means to cause said telephone set to be disconnected from said cord circuit while said calling device is off normal.

38. In a telephone system, a trunk line terminating in a jack, a plug ending cord circuit, a telephone set, a key, self-locking means responsive to the actuation of said key providing the plug of said cord is in said jack and responsive to the insertion of the plug of said cord into said jack providing said key is actuated for connecting said telephone set to said cord circuit, a calling device, and means responsive to the movement of said calling device from its normal position for unlocking said self-locking means to cause said telephone set to be disconnected from said telephone set while said calling device is off-normal, said self-locking means being adapted to reoperate when said calling device again returns to normal.

39. In a telephone system, a trunk line, a first branch normally connected to said trunk line, a second branch normally disconnected from said trunk line, a cord circuit adapted to be connected to said trunk line, a calling device, means responsive to the connection of said cord circuit to said trunk line for disconnecting the first branch from said trunk line and for connecting the second branch to said trunk line, and means responsive to the movement of said calling device from its normal position for disabling said last means and for connecting said calling device to said cord circuit.

40. In a telephone system, a trunk, operating leads, a cord circuit temporarily connected to said trunk, a telephone set and means for connecting it to said cord circuit, a calling device, means responsive to the movement of said calling device from its normal position for disabling said first means, connecting means responsive to said last means for connecting said calling device to said cord circuit, and means responsive to said connecting means for connecting said operating leads to said trunk.

In witness whereof, I hereunto subscribe my name this 24th day of October, A. D., 1925.

THOMAS F. CROCKER.